CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN DIEGO REGION (SDRWQCB)

SUPPLEMENTAL ENVIRONMENTAL PROJECT APPLICATION FORM

Project Requested by City of San Diego

Name of Project **Mission Bay Human Pathogenic Viruses and Epidemiology Combined Study (Epidemiology Study Contribution)**

Date of Request July 23, 2001, Revised September 4, 2001

Point of Contact Karen Henry

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PROJECT SUMMARY:

Despite the importance of Mission Bay as a natural and economic resource, the number of beach closures and postings has increased over the last several years to protect the public's health and safety. Most waterborne illnesses have been linked to the presence of human pathogenic viruses. Over the years, bacterial indicators have been used to determine water quality because of the rapid results, ease of detection and low cost. However, bacterial indicators are not adequate for predicting either the presence of pathogenic viruses or their sources. Recent virology studies have reported the detection of human enteric viruses in recreational waters that meet current bacteriological standards. The use of the Mission Bay waters for recreational purposes could potentially be exposing humans to harmful pathogenic viruses. The human pathogenic virus and the epidemiology studies will be performed concurrently to determine the extent of pathogenic virus contamination and assist in assessing the potential human health risks. The epidemiological study will be conducted at least 3 locations and possibly up to 6 locations on Mission Bay. This study will determine if there is a connection between water contact and human illness, and its frequency. When this phase is completed the process of evaluating the most effective and efficient measures to abate or control the contamination sources can begin. Relative risk as defined in the epidemiological study will be used to guide the priority and resources necessary to control and abate the pollution inputs.

This combined study is funded in part by the State Water Resources Control Board's Cleanup and Abatement Fund. This SEP will fund the balance remaining needed to complete the Epidemiology Study.

TOTAL LIFE CYCLE COST FOR THE PROJECT

Design/Consultant	$0
Construction/Implementation	$700,000
Long Term Maintenance/Oversight	$0
Total (SEP) Project Cost	**$700,00***

*Remaining balance needed to fund entire $1,675,290 for combined study.

WATERSHED/WATERBODY/LOCATION FOR PROJECT

Mission Bay, located in the City of San Diego.

PROJECT PROPOSED START DATE AND TIMELINE:

The Southern California Coastal Water Research Project (SCCWRP) will serve as project coordinator and will assist in selecting the research team for performing the virology/epidemiology combined study. Guidance on the design of the epidemiology study will be provided by Mr. Al Defour, USEPA, representatives from SCCWRP, UCSD, SDSU, USC, Scripps Institute of Oceanography, County of San Diego Department of Environmental Health, County of San Diego Public Health and Heal the Bay. Guidance on the design of the virology study will be provided by UC-Irving, UCSD, SDSU, SCCWRP and the County of San Diego Department of Public Health.

The preliminary study timeline is as follows:

04-01-02	Study development and Select research team.
05-01-02	Prepare study design with research team.
06-01-03	Dry season viral/epidemiology study.
09-01-03	Wet season viral/epidemiology study.
01-01-04	Data coordination, statistical assessment and report generation.
06-01-04	Stakeholder meeting and development of management strategies.

ORGANIZATION SPONSORING PROJECT

San Diego Regional Water Quality Control Board and City of San Diego
Contract Manager: Joan Brackin, Water Resources Engineer

NAME OF PROJECT MANAGER:

Steve Weisberg (or designee), Southern California Coastal Water Research Project (SCCWRP)
Phone: (714) 372-9203

DESCRIPTION OF PROJECT TRUSTEE CAPABILITY OR COMMITMENTS TO ENSURE THAT THE PROJECT WILL BE COMPLETED:

The Southern California Coastal Water Research Project (SCCWRP) is a regional government agency whose charter is the conducting of environmental research with a goal to increase the understanding of the effects of human activities on the ecology of coastal waters of the Southern California Bight.

SCCWRP will serve as project manager for the viral/epidemiology study and will select a research team from various Southern California academic institutions, government agencies and non-government organizations.

DETAILED PROJECT INFORMATION

1. PROPOSAL DESCRIPTION

The combined virology/epidemiology study will determine the relationship between the quality of recreational water in Mission Bay, as measured by both microbial indicators of fecal contamination and the actual viral agents of human disease, and swimming-associated illnesses. This will be achieved through the use of advanced molecular biology and cell biology techniques to detect the presence of viruses associated with human fecal matter and through conducting a cohort epidemiology study. The virology/epidemiology study will provide an assessment of potential human health risks resulting from swimming in Mission Bay water that is subject to impacts from untreated sewage and urban runoff. The project will include, but not be limited to, the following:

1. The exposures of interest will be swimming near flowing storm drains, levels of bacterial indicators (total coliform, fecal coliform and enterococcus) for pathogens that potentially produce acute illness, and human enteric viruses.
2. Beaches that have exhibited chronic bacterial impairment and have a high density of swimmers will be studied, such as beaches adjacent to Bonita Cove, De Anza Cove, Campland and Visitor's Center.

3. The water quality-health study will be carried out on weekend days to maximize the swimmer population.
4. Health inpoints will be measured as reported symptoms from swimmers. Symptomology will include vomiting, diarrhea, fever, nausea, eye discharge, earache, ear discharge, rash, coughing and sore throat.
5. Samples of Mission Bay water will be collected on days that subjects are interviewed and analyzed for bacterial indicators and human enteric viruses.
6. DNA ribotyping, or similar source identification techniques, will be used to delineate human from non-human bacterial input.
7. Swimming-associated illness rate from the Mission Bay beach studies will be regressed against each of the microbial indicators and the viral agents to determine which pathogen shows the "best" relationship to the health data.
8. Statistical analysis of the data will be performed to determine if the relative risks of specific adverse health outcomes are associated with levels of specific bacteria indicators, with non-human sources of bacteria and/or enteric viruses.
9. Results of the virology/epidemiology study will be used to develop specific management strategies to cleanup sources of contamination at affected beaches on Mission Bay.
10. The Mission Bay virology/epidemiology Study will be integrated with other ongoing or pending projects, to include the Mission Bay Water Quality Study (approved SEP for the Alvarado Spill), the Mission Bay Contaminant Dispersion Study, the Mission Bay Source Identification Study, and the Mission Bay Dry Weather Bacterial Source Testing (DNA and other indicators).

The proposed project does not require discretionary permits and environmental review under the California Environmental Quality Act from the City of San Diego.

It may be necessary to modify the scope of work and project schedule for the combined virology/epidemiology study dependent on input from the study design team and preliminary study results. Changes in the project design and schedule are subject to the approval of the Executive Officer of the SDRWQCB. Under no circumstances shall changes in the project design decrease the approved total project cost.

2. PROBLEM STATEMENT

Mission Bay has been on the federal 303(d) list for impaired water bodies since 1988, with the main stressor due to bacterial contamination. Mission Bay has been monitored for total coliform, fecal coliform and enterococci at twenty shoreline stations since 1993. A retrospective analysis of the monitoring data by the consulting firm MEC showed that most bacterial exceedences are concentrated at nine locations around the shoreline of Mission Bay. The analysis also showed increasing water quality degradation over the last three years at five shoreline areas. There are a number of potential sources of contamination in Mission Bay and include input from sanitary sewage overflows, storm drains, animals (birds, cats, dogs), boat septic tanks, and encampments. Each of the sources could potentially be adding bacterial and viral pathogens to the recreational

waters of Mission Bay. Although beaches are posted or closed when bacterial monitoring shows that levels of the bacteria exceed the water quality objectives for recreational water, monitoring is only performed once a week. Thus, swimmers may be routinely exposed to bacterial and viral pathogens during days when the beaches are not monitored. In addition, there is an apparent lack of correlation between bacterial indicators and the actual agents of human disease, such as enteroviruses. To date, there has been only one epidemiology study performed (Santa Monica Bay) which assessed the relative risks for human illness in recreational waters that are contaminated by urban runoff. Furthermore, no epidemiology study has ever been performed in the United States that attempts to link the presence of human viruses in a recreational water with the occurrence of illness in people who swim in those waters.

3. HOW WILL THE PROJECT BENEFIT WATER QUALITY AND BENEFICIAL USES?

Currently, the ability to use many areas of Mission Bay for recreational water activities is limited due to constant posting of the beaches warning beach users that the water is contaminated due to high bacterial counts. Performing a comprehensive viral analysis in the most chronically contaminated areas of Mission Bay will confirm or negate the presence of human viruses. Confirmation of viral elements would narrow the sources of bacterial contamination to human waste. Appropriate management strategies could then be put in place, such as sewer system inspection and repairs, removal of encampments and new ordinances for moored boats, to remediate the sources of human waste. A lack of evidence of human viral elements would focus management strategies on removing non-human bacterial sources, such as better pet waste removal, discouraging large bird flocks from roosting in waters associated with public beaches and controlling bacterial contamination that enters Mission Bay from Rose Creek and Tecolote Creek.

The cohort epidemiology study may, or may not, show significant relative risks associated with swimming in Mission Bay. An outcome of high risks at beaches which are chronically contaminated would mandate that immediate management strategies be implemented (such as temporary beach closures) while appropriate measures are taken to remediate the source(s) of contamination. An epidemiology study that shows a low risk of human illness associated with swimming in Mission Bay not only restores public confidence in the quality of the water, but may eliminate the need to post beaches previously thought to be contaminated, thus, restoring the REC1 beneficial use.

4. HOW WILL THE SUCCESS OF THIS PROJECT BE MEASURED?

Project success will be dependent on the outcome of both the viral analysis and the cohort epidemiology study. Possible scenarios are as follows:

1. A comprehensive viral analysis of water associated with beach areas in Mission Bay that have historically shown chronic bacterial exceedences demonstrates the presence of

human enterovirus. Results of this study allow management strategies to focus on human waste as the source of contamination.

2. The final outcome of the cohort epidemiology study demonstrates a clear risk of human illness associated with swimming at contaminated beaches in Mission Bay. These beaches could be temporarily closed while remediation efforts take place to cleanup the sources of contamination; however, protection of public health is enhanced.

3. The final outcome of the viral study negates the presence of human enteric viruses; however, the epidemiology study demonstrates a clear risk of human illness associated with swimming at contaminated beaches in Mission Bay. Results of this study would allow management strategies to focus on non-human waste as the source of contamination.

4. The outcome of the virology/epidemiology study negates the presence of human enteric viruses in the waters of Mission Bay and demonstrates a low to acceptable level of risk for human illness associated with swimming at Mission Bay. Public confidence in the quality of water in Mission Bay is restored, perceived health threats are greatly diminished and beaches which were previously perceived as contaminated are either no longer posted, or the level of posting is diminished.

Although the combined virology/epidemiology study could potentially demonstrate health risks to swimmers, due to the presence of human viruses, overall success of the project will be measured by the implementation of management strategies that remediate the sources of human fecal matter. Success of these management strategies will be measured by the ability to remediate the sources of contamination from human waste and the subsequent reduction in the number of beach closings and postings in Mission Bay.

5. DETAILED WORK PLAN

Please include a detailed supplemental report of the proposal/project that includes the following:

It may be necessary to modify the scope of work and project schedule for the combined virology/epidemiology study dependent on input from the study design team and preliminary study results. Changes in the project design and schedule are subject to the approval of the Executive Officer of the SDRWQCB. Under no circumstances shall changes in the project design decrease the approved total project cost.

Scope of Work

It is difficult at this time to outline a comprehensive scope of work due to the timing of the project. This project is not scheduled to begin until April 1st, 2002, and will be designed by a project team selected from various Southern California universities and

local agencies. The project team will be lead by SCCWRP and will receive guidance from Al Dufour, USEPA.

Outlined below are elements of the project that are likely to be included in the overall study design:

Beach Areas of Study Interest

The retrospective analysis of Mission Bay monitoring data, as performed by the consulting firm MEC Analytical Systems, Inc. showed that beaches associated with Bonita Cove, De Anza Cove, Visitor's Center, Campland have chronic problems with exceedences of bacterial indicators. These beaches will be reviewed by the project team to validate them as the best study sites.

Analysis of Water for Bacterial Indicators

Water samples for bacterial analysis will be collected on days that subjects are interviewed on the beaches. Samples will be analyzed for total coliform, fecal coliform and enterococci and *e.coli.* Densities of total coliform, fecal coliform and *e. coli* may be determined through use of the IDEXX Colilert colorimetric test and densities of enterococci may be determined using the IDEXX Enterlert colorimetric test. Membrane filtration and multiple tube fermentation assays may also be employed to quantitate levels of indicator bacteria.

Analysis of Water for Viral Elements

Analysis for enteric viruses will be conducted using advanced molecular biology techniques incorporating reverse transcriptase-polymerase chain reaction (RT-PCR) technology. This method will determine the presence of a wide range of human enteric viruses and can be used to quantitate the number of viruses present in a water sample. This methodology has been used to investigate impacts of urban runoff on several Southern California high use beach areas (Dr. Sunny Jiang, UC-Irvine and Dr. Rachael Noble, SCCWRP). To verify that detected viruses are also infective, a standard plaque assay will be performed using a cell type such as Buffalo green monkey kidney cells.

Analysis of Water to Delineate Human vs. Non-human Bacteria

The ability to determine if bacterial contamination is human vs. non-human is a key element in analyzing relative risks to human health from association with recreational waters impacted from urban runoff. Water samples on days when subjects are interviewed will be subject to one or more bacterial source identification techniques, such as DNA ribotyping, antibiotic resistance analysis (ARA) or fatty acid methyl esther analysis (FAME). These techniques are used to determine qualitatively if non-human sources of bacteria, such as from dogs, cats and birds, are responsible for bacterial contamination. These techniques have been used by Dr. Mansour Samadapour,

Washington State University, to investigate sources of bacterial contamination at Dog Beach and at several locations on La Jolla Shores.

Epidemiology Study

The epidemiology study will be performed over approximately ten to sixteen weekend days during the 'dry' season months of June through August, and approximately ten to sixteen days during the 'dry/wet' season months of September through December. The water quality-health study will be carried out on weekend days to maximize the swimmer population. Interviewers will talk to subjects who have reported swimming in the water of Mission Bay. The following elements may be used in the study design:

1. Interviewers will observe swimmers and note whether such persons have immersed their heads in the water.
2. There will be no restrictions based on age, race or sex.
3. The demographics of swimmers shall be noted, such as age, sex and socioeconomic status.
4. Subjects will be asked if they swam at more than one contaminated area of Mission Bay. Subjects swimming in contaminated areas not in the study program will be excluded.
5. Two to three days after the beach interview, subject will be phoned and interviewed again to find whether there was presence of illness such as gastroenteritis, vomiting, fever, chills, respiratory distress, eye irritation, sore throat and earache.
6. Subjects that report illness will be queried as to whether they stayed in bed, missed work or sought medical attention.
7. The data from subject interviews will be summed over the 'dry' testing period and over the 'dry/wet' testing period. Data from bacterial and viral analysis of the water will be used in conjunction with the health data to ascertain relationships between the presence of viral agents and/or bacterial indicators and the onset of human illness.
8. The data from subject interviews will also be used in conjunction with the DNA ribotyping (or other methodology) study to determine if human illnesses are correlated with exposure to bacteria from non-human sources.

Report Generation

A comprehensive, publication-ready report will be generated as a result of the viral/epidemiology study. The study design/research team will review data before it is released for public comment. A written report will be provided to the SDRWQCB, the City of San Diego and the USEPA.

Stakeholders Meeting

One or more stakeholder meetings may be held to discuss the outcome of the viral/epidemiology study. Scientific workshops may be held to link the

viral/epidemiology study with the Mission Bay Dry Weather Source Investigation, the Mission Bay DNA Source Investigation, the Mission Bay Watershed Study and the Mission Bay Contaminant Dispersion Model. These workshops and stakeholder meetings will be used to develop sound scientifically based management strategies to remediate the source of bacterial contamination in Mission Bay.

a. Budget

Project Overhead/Management	$_____
Design/Consultation	$_____
Construction/Implementation	$700,000
Long Term Maintenance/Oversight	$_____
Total Project Cost	$700,000

b. Task descriptions

Design/Consultation: The combined virology/epidemiology study will determine the relationship between the quality of recreational water in Mission Bay, as measured by both microbial indicators of fecal contamination and the actual viral agents of human disease, and swimming-associated illnesses. This will be achieved through the use of advanced molecular biology and cell biology techniques to detect the presence of viruses associated with human fecal matter and through conducting a cohort epidemiology study. The virology/epidemiology study will provide an assessment of potential human health risks resulting from swimming in Mission Bay water that is subject to impacts from untreated sewage and urban runoff.

Construction/Implementation: This project will include:

1. The exposures of interest will be swimming near flowing storm drains, levels of bacterial indicators (total coliform, fecal coliform and enterococcus) for pathogens that potentially produce acute illness, and human enteric viruses.
2. Beaches that have exhibited chronic bacterial impairment and have a high density of swimmers will be studied, such as beaches adjacent to Bonita Cove, De Anza Cove, Campland and Visitor's Center.
3. The water quality-health study will be carried out on weekend days to maximize the swimmer population.
4. Health endpoints will be measured as reported symptoms from swimmers. Symptomology will include vomiting, diarrhea, fever, nausea, eye discharge, earache, ear discharge, rash, coughing and sore throat.
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7. Swimming-associated illness rate from the Mission Bay beach studies will be regressed against each of the microbial indicators and the viral agents to determine which pathogen shows the "best" relationship to the health data.
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c. Regulatory needs

This project does not require discretionary permits and environmental review under the California Environmental Quality Act from the City of San Diego.

d. Schedule

04-01-02	Study development and Select research team.
05-01-02	Prepare study design with research team.
06-01-03	Dry season viral/epidemiology study.
09-01-03	Wet season viral/epidemiology study.
01-01-04	Data coordination, statistical assessment and report generation.
06-01-04	Stakeholder meeting and development of management strategies.

e. Work products and documents to be retained for records

As part of the project, the work plan for the Mission Bay Human Pathogenic Viruses and Epidemiology Combined Study will be prepared to guide the epidemiology and viruses testing protocols and procedures. All documentation and computations will be maintained by SCCWRP. The written report will be provided to the SDRWQCB, the City of San Diego and the USEPA.

f. Other information about the proposed project that may be of interest to the SDRWQCB

Mission Bay is the receiving water for all Tecolote Creek discharges. Effluent from the creek during the February spill was released into Mission Bay and caused the beaches near the mouth of Tecolote Creek to be posted.

I certify that the information provided in this application is an accurate and complete report of the costs, scope of work and expectations of this proposed project I am submitting to the SDRWQCB.

K. Henry

SIGNATURE

9/4/07

Date